(12) UK Patent Application (19) GB (11) 2 282 419 (13) A

(43) Date of A Publication 05.04.1995

(21) Application No 9419768.8

(22) Date of Filing 30.09.1994

(30) Priority Data
(31) 9320342 (32) 02.10.1993 (33) GB

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(51) INT CL[6]
F04B 9/04 43/04

(52) UK CL (Edition N)
F1W WCA W100 W220 W506 W510

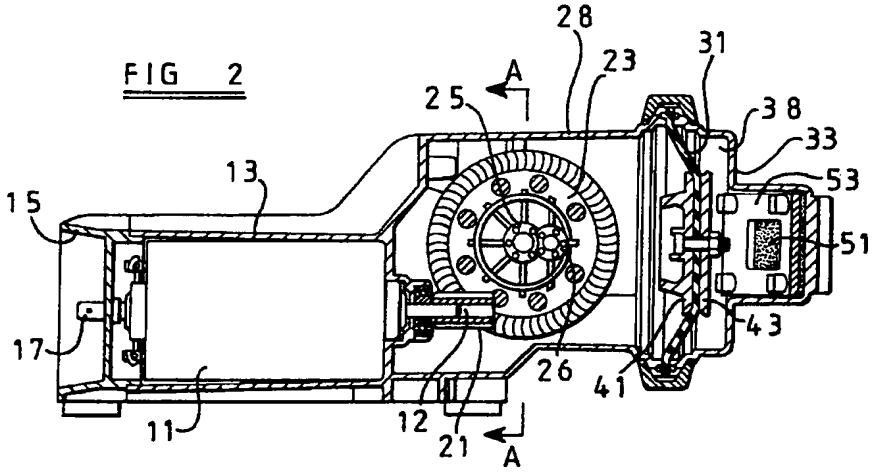
(56) Documents Cited
GB 1371593 A GB 0842308 A GB 0290304 A
GB 0282046 A EP 0148691 A

(58) Field of Search
UK CL (Edition M) F1W WCA
INT CL[5] F04B 9/04 43/02 43/04 45/04
Online databases : WPI

(54) Diaphragm pump

(57) A diaphragm pump including a drive motor (11), a pinion gear (21) on the output shaft (12) of the drive motor, and a drive wheel (23) mounted for rotation about an axis transverse to the axis of the output shaft of the drive motor. The drive wheel (23) has gear teeth on a peripheral region thereof meshing with the pinion gear (21) as a spiroid gear reduction arrangement. A connecting element (39) is pivotally connected at one end to said drive wheel (23) for movement relative thereto about an axis parallel to but spaced from the rotational axis of the drive wheel and at its opposite end cooperates with a pump diaphragm to flex the diaphragm in a reciprocatory manner as the drive wheel (23) is rotated by the motor (11).

FIG 2



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

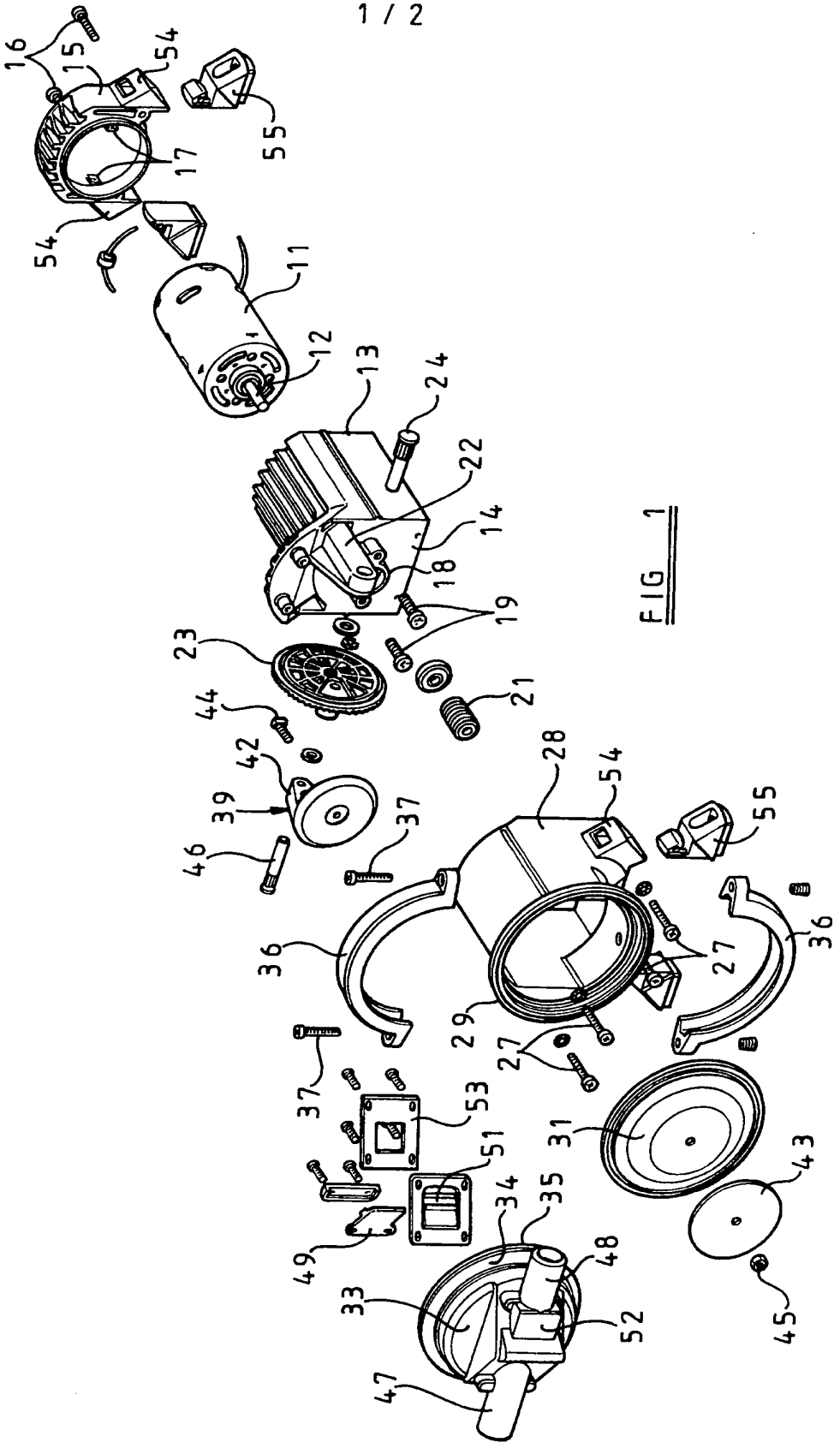
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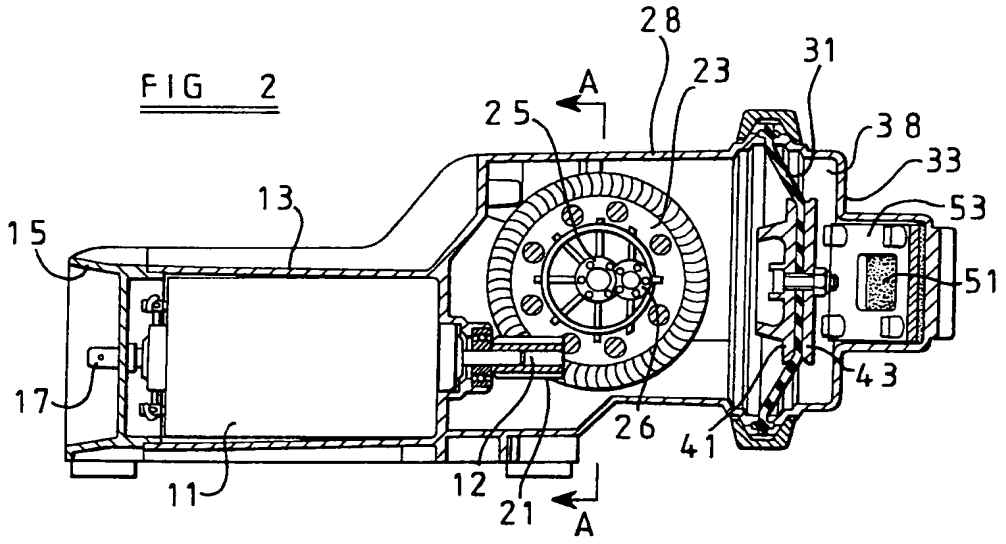
FIG 1

FIG 2



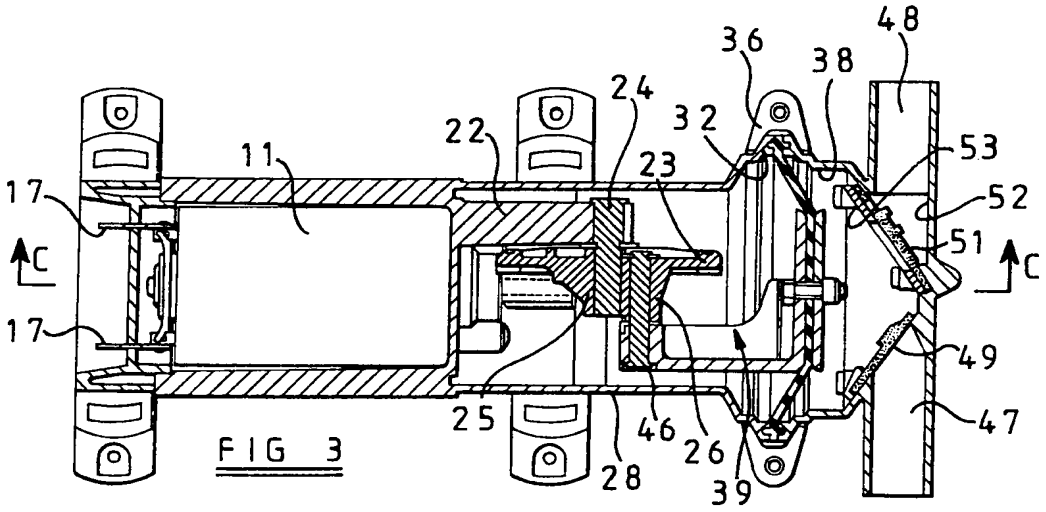


FIG 3

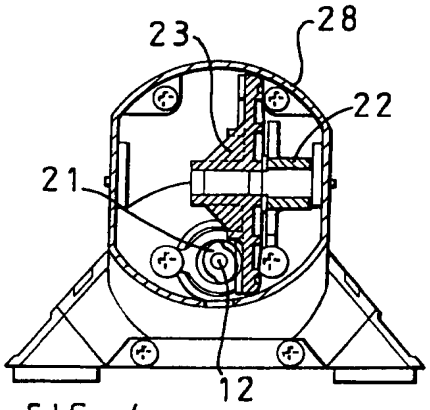


FIG 4

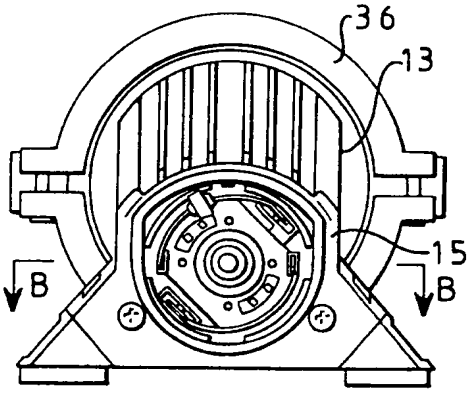


FIG 5

DIAPHRAGM PUMP

This invention relates to a diaphragm pump intended primarily, but not exclusively, for use in boats for discharging collected water. The pump may find use as a bilge pump, or as a pump for discharging overboard water collected from sinks, showers and the like of the boat.

It is known to provide an electrically driven diaphragm pump in which the output of an electric motor is translated, by a crank mechanism, to reciprocal movement of a diaphragm to increase and decrease the volume of a pumping chamber defined in part by the diaphragm. Generally such diaphragm pumps are relatively complex in construction, and it is an object of the present invention to provide a diaphragm pump in a simple and convenient form.

In accordance with the present invention there is provided a diaphragm pump including a drive motor, a pinion gear on the output shaft of the drive motor, a drive wheel mounted for rotation about an axis transverse to the axis of the output shaft of the drive motor and having gear teeth on a peripheral region thereof meshing with said pinion gear, and, a connecting element pivotally connected at one end to said drive wheel for movement relative thereto about an axis parallel to but spaced from the rotational axis of the drive wheel and cooperating at its opposite end with a diaphragm to flex the diaphragm in a reciprocatory manner as the drive wheel is rotated by the motor.

Preferably said connecting element has its region of cooperation with the diaphragm off-set laterally with respect to the motor axis from its point of connection with the drive wheel such that the axis of reciprocatory

movement of the diaphragm can be arranged parallel to the axis of the motor in a common plane lying at right angles to the axis of rotation of the drive wheel.

Preferably said pinion and drive wheel are a spiroid gear arrangement.

Preferably said crank means includes a connecting element pivotally connected at one end to the drive wheel for movement relative thereto about an axis parallel to but spaced from the rotational axis of the drive wheel, and cooperating at its opposite end with the diaphragm.

Desirably the drive wheel is formed as a synthetic resin moulding, and defines its own integral bearings both for the rotational support of the drive wheel, and the pivotal interconnection of the connecting element with the drive wheel.

Conveniently the pump comprises a drive motor housing for receiving said drive motor, a gear housing secured to the drive motor housing and housing said drive wheel and crank means driven by the motor, and a pump cover secured to the gear housing, said diaphragm having its periphery trapped between the gear housing and the pump cover and the pump cover and the diaphragm thus defining a pumping chamber the volume of which can be varied by reciprocatory flexure of the diaphragm.

One example of the present invention is illustrated in the accompanying drawings wherein:-

Figure 1 is an exploded perspective view of a diaphragm pump,

Figures 2 and 3 are, respectively, longitudinal sectional views of an assembled pump, the views being in planes at right angles to one another,

Figure 4 is a transverse sectional view of the pump, and

Figure 5 is an end view of the pump.

The planes of the sectional views of Figures 2, 3 and 4 are indicated in Figures 2, 3 and 5 by appropriate arrows.

Referring to the drawings, the diaphragm pump includes an electric drive motor 11 having an output shaft 12, the motor 11 being received within a hollow, cast metal housing 13. The housing 13 is closed at one end by an integral end wall 14 and is closed at its opposite end by a detachable, moulded synthetic resin, end cap 15. The end cap 15 is secured by screws 16 to the housing 13 and a pair of electrical terminals 17 extend through the end cap for electrical connection to the terminals of the motor 11 within the housing 13. The terminals 17 are accessible at the exterior of the end cap 15 for making electrical connection to the motor.

The end wall 14 of the housing 13 has a centrally disposed aperture surrounded by an integral boss 18, the boss 18 projecting outwardly from the outer face of the wall 14. The output shaft 12 of the motor 11 projects forwardly through the aperture and the boss 18 and screws 19 extend on opposite sides of the boss 18, through the wall 14 and into engagement with the casing of the motor 11, within the housing 13, to retain the motor in position in the housing 13. The boss 18 supports the

outer race of a ball bearing, the inner race of which is carried by the shaft 12. The shaft 12 projects beyond the bearing and secured thereto is a pinion 21.

Integral with the motor housing 13 and projecting forwardly from the wall 14 thereof parallel to the motor shaft 12, is a drive wheel support bracket 22. A moulded synthetic resin drive wheel 23 is rotatably mounted on the bracket 22 by means of a pivot pin 24 which is drive fitted into a transverse bore of the bracket 22. The pin 24 projects beyond the bracket 22 and into a central bore of the drive wheel 23 so that the wheel 23 can rotate on the pin. The material of the wheel 23 is "self-lubricating" and thus no intervening bearing is needed between the wheel 23 and the pin 24.

The central bore of the wheel 23 is defined in part in an integral, centrally disposed bush 25 projecting from the face of the wheel 23 remote from the bracket 22. A second, similar integral bush 26 also projects from the face of the wheel 23 remote from the bracket 22, the bush 26 being parallel to but spaced from the bush 25. Thus the axis of the bush 26 is spaced from the rotation axis of the wheel 24.

The peripheral region of the face of the wheel 23 remote from the bracket 22 is formed with a row of gear teeth which mesh with a spiral gear form on the outer surface of the pinion 21. The nature of the gear form and gear teeth is such that the pinion and wheel define a spiroid gear drive. As is apparent from the drawings the rotational axis of the pinion is at right angles to, and is spaced from, the rotational axis of the drive wheel 23, and thus the meshing of the pinion and the drive wheel occurs adjacent a tangent to the periphery of the wheel. The spiroid

gear arrangement effects a reduction gearing such that the wheel is rotated one complete revolution for every thirty one revolutions of the pinion.

Secured by screws 27 to the motor housing 13 is a moulded synthetic resin gear housing 28 within which the drive wheel 23 and the bracket 22 are received. At its end remote from the housing 13 the housing 28 is circular and defines a face 29 at right angles to the axis of the motor 11 and shaft 12. The face 29 is a seating face for a diaphragm 31 and has a circumferential groove therein for receiving a sealing bead integral with the periphery of the diaphragm 31. The exterior of the housing 28 adjacent the face 29 defines a frusto-conical flange 32, and a moulded synthetic resin pump cover 33 is provided with a similar frusto-conical flange 34 and grooved face 35. The periphery of the diaphragm 31 is trapped between the face 35 of the cover 33 and the face 29 of the housing 28 with integral sealing beads on opposite faces of the peripheral edge region of the diaphragm 31 engaging in the respective circumferential grooves of the faces 35 and 29 respectively. A two part moulded synthetic resin clamping ring 36 having appropriately shaped internal surfaces engages the frusto-conical flanges 34 and 32 and as the two halves of the ring 36 are pulled towards one another by securing screws 37 the cover 33 is axially loaded against the housing 28 trapping the diaphragm therebetween and effecting a seal around the periphery of the diaphragm. The diaphragm 31 and the interior of the cover 33 together define a pumping chamber 38 the volume of which can be varied by flexure of the diaphragm.

A moulded synthetic resin connecting element 39 links the wheel 23 and the diaphragm 31. The connecting element 39 includes a disc-like

portion 41 and an integral connecting leg off-set from the axis of the portion 41 and extending from a peripheral region of the portion 41 at right angles to the plane thereof. The outer face of the portion 41 of the connecting element 39 engages the central region of the diaphragm 31 and a moulded synthetic resin clamp plate 43 of diameter similar to the diameter of the portion 41, engages the central region of the diaphragm 31 on its face remote from the portion 41. A clamping bolt 44 extends through the portion 41, the diaphragm 31, and the plate 43 and is engaged by a nut 45 such that the central region of the diaphragm 31 is clamped to the portion 41 by the clamp plate 43.

The end of the connecting leg 42 of the element 39 remote from the portion 41 has a transverse bore through which a steel crank pin 46 extends as a drive fit. The crank pin 46 projects from the leg 42 and is rotatably received in the bore of the boss 26 of the drive wheel 23. The crank pin projects through the drive wheel 23 and a circlip engaged with the crank pin retains the drive wheel 23 on the pin 46. A thrust washer conveniently is interposed between the axial end of the boss 26 and the connecting leg 42. It will be recognised that rotation of the drive wheel 23 results in the axis of the crank pin orbiting around the axis of rotation of the drive wheel and thus the central region of the diaphragm 31 connected to the element 39 is caused to reciprocate towards and away from the axis of rotation of the drive wheel. Thus the volume of the pumping chamber 38 is increased and decreased in accordance with rotation of the drive wheel.

The pump cover 33 is formed with axially aligned and oppositely directed inlet and outlet pipes 47, 48 which open into the pumping chamber 38 and have associated with them respective inlet and outlet

valves. The inlet valve is defined by a flexible rubber flap 49 of generally rectangular form clamped along one of its edges to the inner surface of the cover 33. The natural resilience of the flap 49 causes it to lie across the opening of the inlet pipe 47 so that it can be deflected inwardly to allow flow into the chamber 38, but any attempt to cause a flow out of the chamber 38 will press the flap firmly against the interior surface of the cover 33 thus preventing flow back along the inlet pipe. The outlet valve associated with the outlet pipe 49 is similarly defined by a flexible rubber flap 51 the flap 51 being deflectable into an outlet chamber 52 of the cover 33 but being pressed, by its inherent resilience against the inner face of a rectangular cover plate 53 secured by screws to the inner surface of the cover 33. The plate 53 has a rectangular aperture through which part of the area of the flap 51 is exposed to pressure conditions within the chamber 38, and thus during a pumping stroke as the diaphragm moves to reduce the volume of the chamber 38 the flap 51 is deflected away from the plate 53 and into the chamber 52 to allow liquid to be discharged from the chamber 38 through the chamber 52 and the outlet pipe 48. However, during a return stroke when the diaphragm is moving to increase the pump chamber volume then the flap 51 is sucked back against the plate 53 around its rectangular aperture, thus sealing the aperture and preventing flow of liquid back through the pipe 48 and the chamber 52 into the pumping chamber 38.

In known diaphragm pumps utilizing a crank mechanism to translate rotary motion of the drive motor into reciprocation of the diaphragm there is some form of worm and pinion reduction drive whereby the motor drives a gear wheel, but the gear wheel is attached to a driven shaft, and the shaft then carries a crank arrangement coupled to a

connecting rod in turn coupled to the diaphragm. In the known arrangements therefore torque from the motor is transmitted from a driven gear wheel to a shaft, and from the shaft to a crank mechanism. Both the gear wheel and the crank mechanism are therefore required to be individually keyed to a shaft in such a way that appropriate torque loadings can be accommodated. By comparison, in the present invention the driven wheel 23 forms part of the crank mechanism and is coupled directly to the connecting rod (the connecting element 39) by means of a crank pin. Such an arrangement provides a pump which is simpler to construct and assemble and which can be more compact. Moreover, using such an arrangement with the L-shaped (off-set) connecting element 39 the axis of movement of the diaphragm and the axis of the motor can be arranged parallel to one another in a plane at right angles to the axis of rotation of the drive wheel. Such an arrangement of axes is facilitated by the offset nature of the connecting rod and this in turn facilitates the production of a compact design in which forces applied to the various components can balance.

It will be recognised also that the motor housing 13, in addition to providing housing for the electric motor, provides a mounting point for the gear housing, and also provides cooling for the electric motor. It will be noted that the housing is formed with integral fins which assist heat dissipation by convection whether the pump is mounted with the motor axis horizontal, or vertical. The moulded synthetic resin end cap 15 and the moulded synthetic resin gear housing 28 are formed with hollow lugs 54 shaped to receive moulded resin or rubber feet 55 through which mounting bolts can pass to effect a resilient mounting of the pump assembly.

CLAIMS

1. A diaphragm pump including a drive motor, a pinion gear on the output shaft of the drive motor, a drive wheel mounted for rotation about an axis transverse to the axis of the output shaft of the drive motor and having gear teeth on a peripheral region thereof meshing with said pinion gear, and, a connecting element pivotally connected at one end to said drive wheel for movement relative thereto about an axis parallel to but spaced from the rotational axis of the drive wheel and cooperating at its opposite end with a diaphragm to flex the diaphragm in a reciprocatory manner as the drive wheel is rotated by the motor.

2. A pump as claimed in Claim 1, wherein said connecting element has its region of cooperation with the diaphragm off-set laterally with respect to the motor axis from its point of connection with the drive wheel such that the axis of reciprocatory movement of the diaphragm is arranged parallel to the axis of the motor in a common plane lying at right angles to the axis of rotation of the drive wheel.

3. A pump as claimed in Claim 1 or Claim 2, wherein the arrangement of said pinion gear wheel and said drive wheel is a spiroid gear arrangement.

4. A pump as claimed in any one of Claims 1 to 3, wherein the drive wheel is formed as a synthetic resin moulding, and defines its own integral bearings both for the rotational support of the drive wheel, and the pivotal interconnection of the connecting element with the drive wheel.

5. A pump as claimed in any one of Claims 1 to 4 comprising a drive motor housing for receiving said drive motor, a gear housing secured to the drive motor housing and housing said drive wheel and crank means driven by the motor, and a pump cover secured to the gear housing, said diaphragm having its periphery trapped between the gear housing and the pump cover and the pump cover and the diaphragm thus defining a pumping chamber the volume of which can be varied by reciprocatory flexure of the diaphragm.

6. A diaphragm pump substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) - 11 -	Application number GB 9419768.8
Relevant Technical Fields (i) UK Cl (Ed.M) F1W (WCA) (ii) Int Cl (Ed.5) F04B 43/02, 43/04, 45/04, 9/04	Search Examiner B W DENTON Date of completion of Search 16 NOVEMBER 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASE: WPI	Documents considered relevant following a search in respect of Claims :- 1 TO 6

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
Y	GB 1371593	(PIERBURG) note wheel 37; connecting element 31; and diaphragm 14	1
Y	GB 0842308	(GUINARD) see connecting element 19 and diaphragm 9	1
Y	GB 0290304	(SEIGNOL) whole document	1
Y	GB 0282046	(LÜBKE) whole document but especially Figure 2	1
A	EP 0148691	(ROY) see particularly Figure 1	1

Databases:The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents) The on-line databases considered for search are also listed periodically in the Official Journal (Patents).